IV&V Dynamic Test and Analysis with the Orion Multi-Purpose Crew Vehicle Flight Software

Introduction

The Human Exploration & Operations – Exploration Systems Development (HEO-ESD) IV&V team is currently conducting analysis of development of the flight software for the first flight of the Orion Multi-Purpose Crew Vehicle (MPCV). As part of that process, the HEO-ESD IV&V team will conduct dynamic analysis of the flight software using simulation and test software provided to the Independent Test Capability (ITC) team's Jon McBride Software Testing and Research (JSTAR) laboratory by the Orion MPCV project.

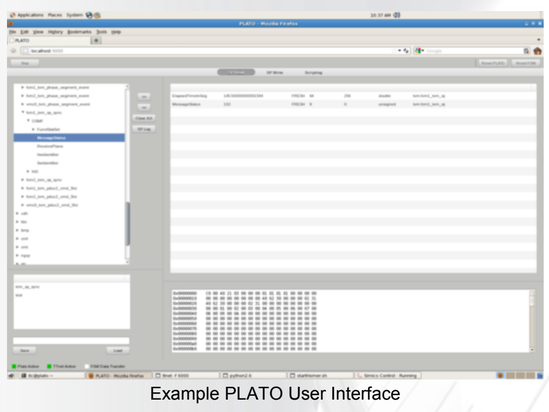
IV&V Analysis Challenges

- Providing value while mitigating issues
- Inheritance of legacy code paradigm
  - i.e. non-conformity of source code languages
- Dual fault testing
- Run time regressing testing
- Complexity of FSW architecture
  - Systems of systems vs. simple monolithic hierarchical design
  - Exponential increase in difficulty with analysis of behavior interactions across interfaces

PLATO

Partition Level Application Test for Orion

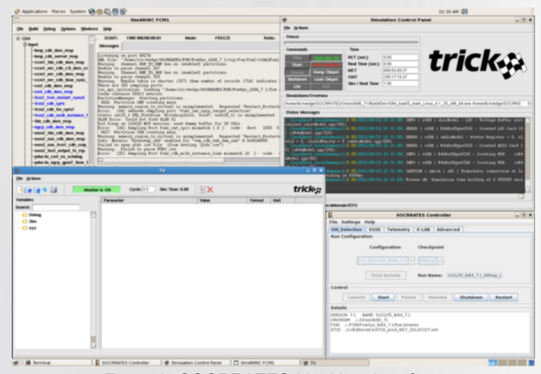
- Developed by NASA at the Johnson Space Center
- Local installation managed by ITC
- Partition is the natural boundary for Orion Integrated Modular Architecture FSW
- Allows for execution of unmodified flight binary on an emulated Simics target
- Evaluation of the partition interfaces ensures that interface agreements have been met
- Allows single stepping through FSW minor frames



Example PLATO User Interface

Dynamic Analysis Advantages

- Identifies run-time vulnerabilities
- Provide increased flexibility of what to look for
- Identifies vulnerabilities that may have been false negatives in static analyses
- Validation of static analysis finding
- Dual fault testing



Example SOCRRATES-Lite User Interface

SOCRRATES

Software Only CEV Risk Reduction Analysis Test Environment Simulation

- Developed by Lockheed Martin
- Local installation managed by ITC
- No formal verification is being conducted on the test environment
  - **SOCRRATES Lite** – *Simulation environment with the MPCV flight software modified and compiled to run on Linux*
  - **SOCRRATES Heavy** – *Simulation environment that executes the unmodified MPCV flight software on an emulated Simics target*

Dynamic Analysis Benefits for IV&V

- Test independently from developer
- Provides ability to observe and evaluate behavior of the FSW under operational and environmental conditions
- Provide evidence based test results to support IV&V issues and severity assessment presented to the project
- Identification of improvement areas to the development test design
- Can investigate areas where IV&V feels more test coverage would be beneficial
- Will give the project and IV&V added assurance that the software is working the way intended and reacts to adverse conditions properly
- Capable of regression testing in a more rigorous manner

NASA Independent Verification and Validation Facility
Fairmont, West Virginia

Ricky Beamer
frederick.m.beamer@ivv.nasa.gov

Eric Weasenforth
eric.d.weasenforth@ivv.nasa.gov